Experiment No: 1

P-N JUNCTION DIODE CHARACTERISTICS

AIM:

1. To plot Volt-Ampere Characteristics of Silicon P-N Junction Diode.
2. To find cut-in Voltage for Silicon P-N Junction diode.
3. To find static and dynamic resistances in both forward and reverse biased conditions for Si P-N Junction diode.

Components:

Name	Qty
Diode IN 4007(Si)	1
Resistor 1KΩ, 10KΩ	1

Specifications of Diode:

For Silicon Diode 1N 4007: -

Max. Forward Current	= 1A
Max. Reverse Current	= 30μA
Max. Forward Voltage	= 0.8V
Max. Reverse Voltage	= 1000V
Max. Power dissipation	= 30mw
Temperature	= - 65 to 200^0C

Software Required:

Multisim

Theory:

Donor impurities (pentavalent) are introduced into one-side and acceptor impurities into the other side of a single crystal of an intrinsic semiconductor to form a p-n diode with a Junction called depletion region (this region is depleted off the charge carriers). This Region gives rise to a potential barrier Vγ called ***Cut- in Voltage***. This is the voltage across the diode at which it starts conducting. It can conduct beyond this Potential.

The P-N junction supports uni-directional current flow. If +ve terminal of the input supply is connected to anode (P-side) and –ve terminal of the input supply is connected to cathode (N- side) then diode is said to be forward biased. In this condition the height of the potential barrier at the junction is lowered by an amount equal to given forward biasing voltage. Both the holes from p-side and electrons from n-side cross the junction simultaneously and constitute a forward current (***injected minority current*** – due to holes crossing the junction and entering N-side of the diode, due to electrons crossing the junction and entering P-side of the diode). Assuming current flowing through the diode to be very large, the diode can be approximated as short-circuited switch.

If –ve terminal of the input supply is connected to anode (p-side) and +ve terminal of the input supply is connected to cathode (n-side) then the diode is said to be reverse biased. In this condition an amount equal to reverse biasing voltage increases the height of the potential barrier at the junction. Both the holes on p-side and electrons on n-side tend to move away from the junction thereby increasing the depleted region. However the process cannot continue indefinitely, thus a small current called ***reverse saturation current*** continues to flow in the diode. This small current is due to thermally generated carriers. Assuming current flowing through the diode to be negligible, the diode can be approximated as an open circuited switch.

The volt-ampere characteristics of a diode explained by following equation:

$I = I_0 (e^{V/(\eta V_T)} - 1)$ where

I=current flowing in the diode I_0=reverse saturation current

V=voltage applied to the diode

V_T=volt-equivalent of temperature=kT/q=T/11,600=26mV (@ room temp).

η=1 (for Ge) and 2 (for Si)

It is observed that Ge diode has smaller cut-in-voltage when compared to Si diode. The reverse saturation current in Ge diode is larger in magnitude when compared to silicon diode.

<u>Fig (1) - Forward Biased Condition:</u>

Procedure:

Forward Biased Condition:

1. Connect the circuit as shown in figure (1) using silicon PN Junction diode.
2. Vary V_f gradually in steps of 0.1 volts upto 5volts and note down the corresponding readings of I_f.
3. Step Size is not fixed because of non linear curve and vary the X-axis variable (i.e. if output variation is more, decrease input step size and vice versa).
4. Tabulate different forward currents obtained for different forward voltages.

Reverse biased condition:

1. Connect the circuit as shown in figure (2) using silicon PN Junction diode.
2. Vary V_r gradually in steps of 0.5 volts upto 8 volts and note down the corresponding readings of I_r.
3. Tabulate different reverse currents obtained for different reverse voltages. ($I_r = V_R$ / R, where V_R is the Voltage across 10KΩ Resistor).

Observations

Si diode in forward biased conditions:

Sl. No	RPS Voltage	Forward Voltage across the diode V_f (volts)	Forward current through the diode I_f (mA)

Si diode in reverse biased conditions:

Sl. No	RPS Voltage	Reverse Voltage across the diode V_r (volts)	Reverse current through the diode I_r (μA)

Graph (Instructions):

1. Take a graph sheet and divide it into 4 equal parts. Mark origin at the center of the graph sheet.
2. Now mark + ve x-axis as V_f
   - Ve x-axis as V_r
   + Ve y-axis as I_f
   - ve y-axis as I_r.

3. Mark the readings tabulated for Si forward biased condition in first Quadrant and Si reverse biased condition in third Quadrant.

Model Graph:

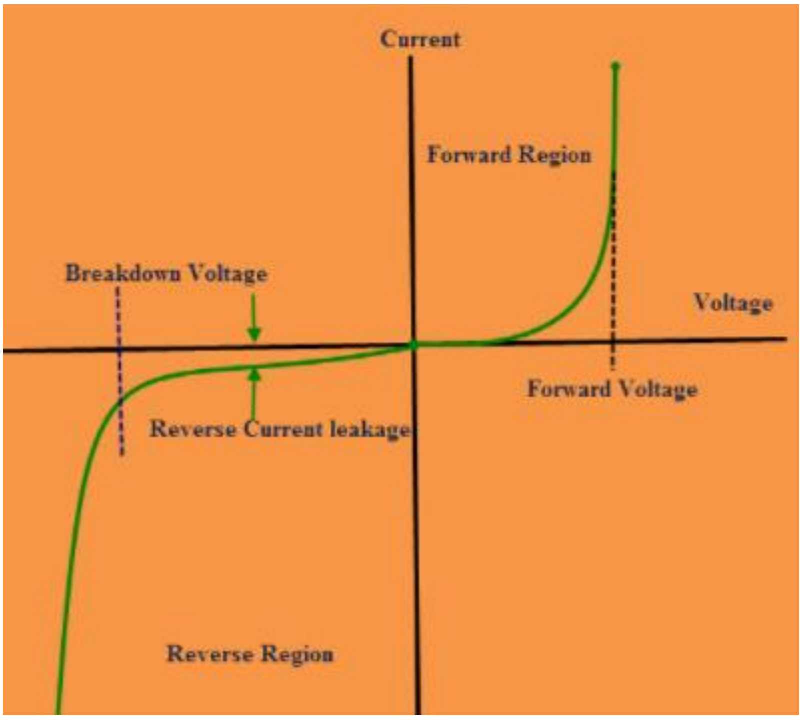

Figure: VI Characteristics of PN Junction Diode

Calculations:

Static forward Resistance $R_{dc} = V_f / I_f\ \Omega$
Dynamic forward Resistance $r_{ac} = \Delta V_f / \Delta I_f\ \Omega$
Static Reverse Resistance $R_{dc} = V_r / I_r\ \Omega$

Result:

1. Cut in voltage = ……… V
2. Static forward resistance =................. Ω
3. Dynamic forward resistance = ...Ω

Conclusions : The VI characteristics of PN Junction Diode is plotted and the forward resistance, reverse resistance and cutin voltage of diode is calculated.